

Time : 60 minutes
Summer 2007

Chemistry 201
Quiz 1

July 18, 2007
R. Sultan

Name : _____ **KEY** _____

Major : _____

Student Number : _____

Signature : _____

Useful Information

Planck's constant $h = 6.626 \times 10^{-34} \text{ J s}$

Speed of light $c = 2.998 \times 10^8 \text{ m s}^{-1}$

Constant for the Bohr energy levels $C = 2.18 \times 10^{-18} \text{ J}$ (Rydberg's constant)

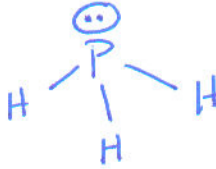
$1 \text{ nm} = 10^{-9} \text{ m}$

Mass of electron $m_e = 9.109 \times 10^{-31} \text{ kg}$

There are 20 questions. In each question, only ONE of the proposed answers is right. Circle the letter corresponding to the right answer.

- According to VSEPR theory, the geometry of the PH_3 molecule is best described as

- A. linear.
- B. trigonal planar.
- C. tetrahedral.
- D. bent.
- E. trigonal pyramidal.



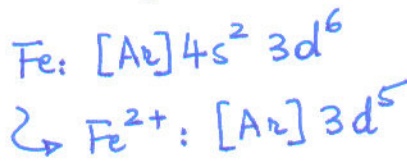
- Which element has the following electron configuration?



- A. Sn
- B. Sb
- C. Pb
- D. Bi
- E. Te

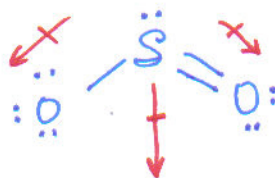
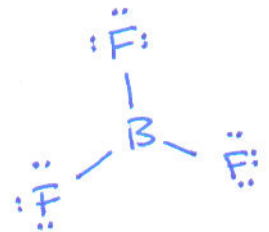
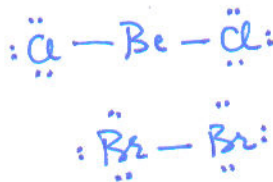
- Which of the following is the electron configuration of the Fe^{3+} ion?

- A. $[\text{Ar}]3d^5$
- B. $[\text{Ar}]4s^1 3d^5$
- C. $[\text{Ar}]4s^2 3d^3$
- D. $[\text{Ar}]3d^6$
- E. $[\text{Ar}]4s^2 3d^9$



- Which one of the following molecules has a dipole moment?

- A. BeCl_2
- B. Br_2
- C. BF_3
- D. SO_2
- E. CO_2



- Calculate the wavelength of a neutron that has a velocity of 200 cm/s. The mass of a neutron = 1.675×10^{-27} kg.

- A. 1.98×10^{-9} m
- B. 216 nm
- C. 1.8×10^{50} m
- D. 198 nm**
- E. 5.05 mm

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.626 \times 10^{-34}}{1.675 \times 10^{-27} \times 200 \times 10^{-2}}$$

$$= 1.98 \times 10^{-7} \text{ m} \equiv \boxed{198 \text{ nm}}$$

- What is the energy in joules of a mole of photons associated with red light of wavelength 7.00×10^2 nm?

- A. 256 kJ
- B. 1.71×10^5 J**
- C. 4.72×10^{-43} J
- D. 12.4 kJ
- E. 2.12×10^{42} J

$$E = N_A \epsilon = h\nu = \frac{hc}{\lambda} \otimes N_A$$

$$= 6.626 \times 10^{-34} \times \frac{2.998 \times 10^8}{7.00 \times 10^2 \times 10^{-9}} \times 6.023 \times 10^{23}$$

$$= \boxed{1.71 \times 10^5 \text{ J}}$$

- What is not common between the Lewis structures of NO_3^- , CO_3^{2-} and SO_3 ?

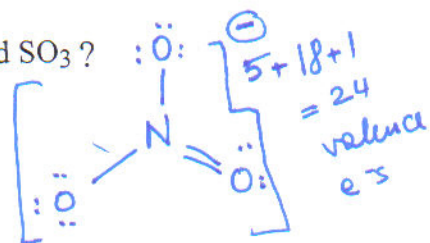
A. They are all isoelectronic. ✓ (valence)

B. They all have three resonance contributing structures. ✓

C. Their resonance structures are not equivalent. No, they are!

D. When considered from the viewpoint of VSEPR theory, they are yield trigonal planar molecules. ✓

E. For each molecule, each resonance structure has two single bonds and one double bond. ✓



- In which one of the following molecules is the central atom sp^2 hybridized?

sp^2 **A. SO_2**

sp B. N_2O

sp C. BeCl_2

sp^3 D. NF_3

dsp^3 E. PF_5

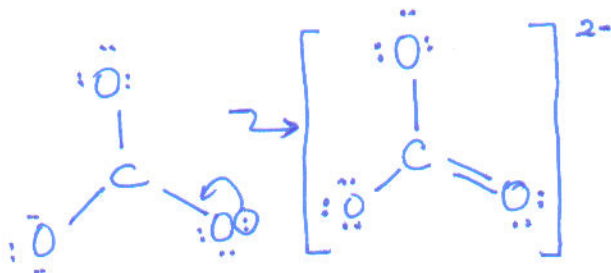
$$\text{N}_2\text{O}: 5 \times 2 + 6 = 16 - 4 = 12$$



$\text{SO}_3 \equiv 24$ valence
same idea...

$$\text{CO}_3^{2-}: 4 + 18 + 2 = 24$$

valence



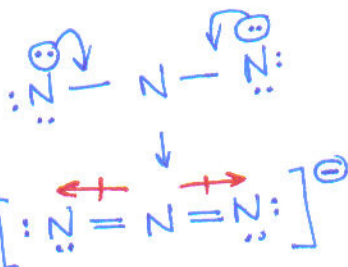
- Which one of the following elements is a transition element?

A. Sr
 B. Pb
 C. As
 → **D. Hg**
 E. H

- Which one of the following molecules is nonpolar?

A. NH₃
 B. OF₂
 C. CH₃Cl
 D. H₂O

$$\text{N}_3^- \quad 5 \times 3 + 1 = \frac{16}{\frac{4}{12}}$$



E. N₃⁻

- A possible set of quantum numbers for the last electron added to complete an atom of germanium (Ge) in its ground state is

n	l	m _l	m _s
A. 4	0	0	+ 1/2
B. 3	0	+1	- 1/2
C. 4	1 ✓	-1 ✓	+ 1/2 ✓
D. 3	1	+1	- 1/2
E. 4	2	+2	- 1/2

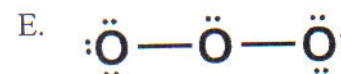
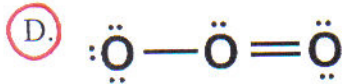
last e⁻ is in 4p

not possible (d e⁻)

- Consider an element with the following electron configuration: [Xe]6s²4f⁷. What is this element?

A. Sm
B. Eu
 C. Gd
 D. Am
 E. Cm

- Which one is a correct Lewis structure for ozone, O_3 ?

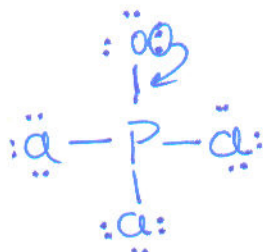
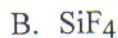


O_3 $\frac{18 e^-}{4} = \frac{14}{}$

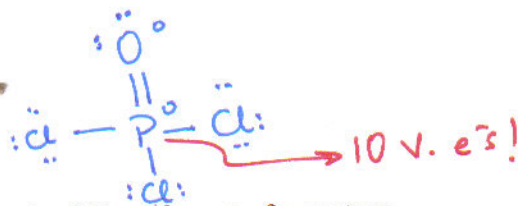


- Which one of the following compounds does not follow the octet/duet rule?

Hint: Consider the BEST Lewis structure in each case.



$POCl_3: 5 + 6 + 21 = \frac{32 e^-}{8} = \frac{24}{}$

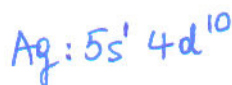
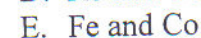
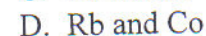
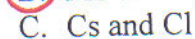
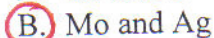
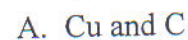


- The maximum number of electrons in a atom that have the following set of quantum numbers is:

$n = 4 \quad l = +3 \quad m_l = -2 \quad m_s = +1/2$



- Which choice lists two elements with electron configurations that are well-known exceptions to the Aufbau principle?



- Calculate the wavelength, in nanometers, of the light emitted by a hydrogen atom when its electron falls from the $n = 7$ to the $n = 4$ principal energy level. Recall that the energy levels of the H atom are given by:

$$E_n = -2.18 \times 10^{-18} \text{ J } (1/n^2)$$

- A. $4.45 \times 10^{-20} \text{ nm}$
- B. $2.17 \times 10^{-6} \text{ nm}$
- C. $9.18 \times 10^{-20} \text{ nm}$
- D. $1.38 \times 10^{14} \text{ nm}$
- E. $2.17 \times 10^3 \text{ nm}$**

$$\Delta E = R_H \left(\frac{1}{16} - \frac{1}{49} \right) = \frac{hc}{\lambda}$$

$$= 2.18 \times 10^{-18} (0.0421) = \frac{hc}{\lambda}$$

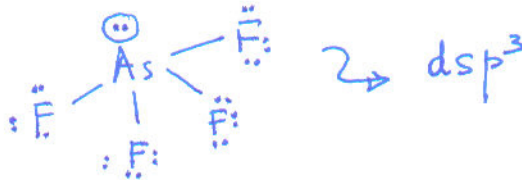
$$\lambda = 2.16 \times 10^{-6} \text{ m}$$

$$\equiv \boxed{2.16 \times 10^3 \text{ nm}}$$

- What is the hybridization of As in the AsF_4^- ion?

- A. sp
- B. sp^2
- C. sp^3
- D. sp^3d**
- E. sp^3d^2

$$5 + 7 \times 4 + 1 = 34 \text{ e}^-s - 8 = 26$$



- The work function for potassium (K) is 2.25 eV. Calculate the kinetic energy of the ejected electron when a photon of wavelength 490 nm hits the surface of a potassium metal sheet.

- A. 4.78 eV
- B. 0.28 eV**
- C. 2.53 eV
- D. 0.18 eV
- E. 3.65 eV

$$E = h\nu = \frac{hc}{\lambda} = 4.05 \times 10^{-19} \text{ J}$$

$$\equiv 2.53 \text{ eV}$$

$$E = \underbrace{h\nu_0}_{\text{work function}} + K.E$$

$$\rightarrow K.E = E - \phi$$

$$= 2.53 - 2.25$$

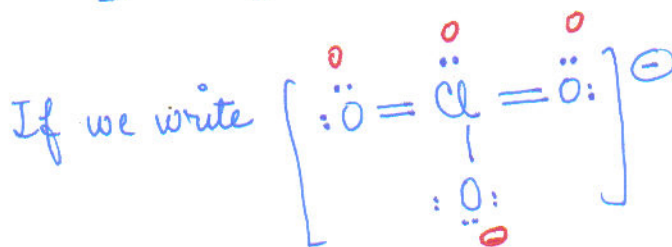
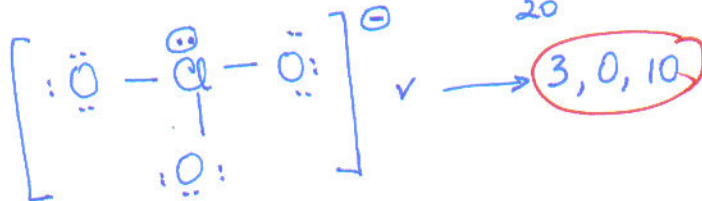
$$= \boxed{0.28 \text{ eV}}$$

- The Lewis structure for a chlorate ion, ClO_3^- , should show ___ single bond(s), ___ double bond(s), and ___ lone pair(s).

- A. 2, 1, 10
- B. 3, 0, 9
- C. 2, 1, 8
- D. 3, 0, 10**
- E. 2, 1, 10

$$\text{ClO}_3^- : 7 + 18 + 1 = 26$$

$$\frac{6}{20}$$



1, 2, 8

No choice for this!